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ABSTRACT

A field test of a computer-assisted instruction (CAI) program of inservice education in modern mathematics and mathematics teaching methods for elementary teachers was conducted at California, Pennsylvania in the summer of 1969. The course, called "elmath", consisted of 80% mathematical content and 20% teaching methods, with the methods units interspersed throughout so that each would be studied immediately following the presentation of related content. Results of various analyses of data gathered during the course from the 130 participants showed that the program was effective in providing inservice education for teachers of elementary school mathematics and other educators, that the program increased favorable attitudes toward mathematics, that the content of the course was probably learned faster in the CAI format than in a conventional classroom, that the course needed several revisions, and that both high and low achievers expressed favorable opinions toward CAI. Appended is a course description of "elmath" and a student opinion questionnaire. EM 011 037 through EM 011 043, EM 011 046, EM 011 047, and EM 011 049 through EM 011 058 are related documents. (SH)

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COMPUTER ASSISTED INSTRUCTION LABORATORY

COLLEGE OF EDUCATION · CHAMBERS BUILDING

THE PENNSYLVANIA STATE UNIVERSITY · UNIVERSITY PARK, PA.

INSERVICE MATHEMATICS EDUCATION FOR ELEMENTARY SCHOOL TEACHERS VIA COMPUTER-ASSISTED INSTRUCTION

INTERIM REPORT

November 21, 1969

Report No. R-25

EM 011 642

Note to accompany the Penn State Documents.

In order to have the entire collection of reports generated by the Computer Assisted Instruction Lab. at Penn State University included in the ERIC archives, the ERIC Clearinghouse on Educational Media and Technology was asked by Penn State to input the material. We are therefore including some documents which may be several years old. Also, so that our bibliographic information will conform with Penn State's, we have occasionally changed the title somewhat, or added information that may not be on the title page. Two of the documents in the CARE (Computer Assisted Remedial Education) collection were transferred to ERIC/EC to abstract. They are Report Number R-36 and Report Number R-50.

-- JoAnn Carroll: /ERIC/EM

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The Pennsylvania State University

Computer Assisted Instruction Laboratory
University Park, Pennsylvania

INSERVICE MATHEMATICS EDUCATION FOR ELEMENTARY SCHOOL TEACHERS VIA COMPUTER-ASSISTED INSTRUCTION

California, Pennsylvania

Sponsored by

The Appalachia Educational Laboratory, Inc.
Charleston, West Virginia

Principal Investigator

Keith A. Hall

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Interim Report
November 21, 1969

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PREFACE

California is a small community in Washington County, Pennsylvania, about thirty miles south of Pittsburgh. One of its modern elementary schools was the site of the third setting for the computer-based, mobile, inservice teacher education program sponsored by the Appalachia Educational Laboratory of Charleston, West Virginia, in cooperation with The Pennsylvania State University, the Pennsylvania State Department of Education, and the International Business Machines Corporation. Two earlier seven-week experiences in March through April and May through June of this year were conducted at Dryden, Virginia (Lee County), and Gladeville, Virginia (Carroll County), and reports (Computer Assisted Instruction Laboratory, The Pennsylvania State University, R-19 and R-22 respectively) were prepared by the authors of the present document. A consolidated report summarizing the experiences and the products of the three settings will be available by the end of 1969.

Many educators have heard that there is such a phenomenon as computer-assisted instruction, but most are unaware that the technique is beyond the developmental or laboratory stage and is ready for limited operational use in carefully selected situations. One such educational situation for which there is an urgent need is the retraining and upgrading of teachers who are currently in service. Because teachers frequently find it impossible for personal reasons to return to college campuses, the re-education they need should be taken to them. This solution to the problem of inservice education gave rise to the "extension class," which has enjoyed widespread application during the past four decades. It is, however, getting more and more difficult to staff these field courses with qualified instructors. Hence, the whole field of continuing education is ripe for a technological innovation that will bring quality instruction to practitioners in the field. At the close of the present cycle of three computer-based instructional settings in modern mathematics on August 31, 1969, we have provided a two-credit college course to approximately three hundred and seventy-five educators. This report and the

previous ones based on the Dryden and Gladeville experiences show that the computer-assisted instruction technique is successful. The students, many of whom thought that they were through with learning activities, show growth in knowledge and a high degree of enthusiasm for the individualized technique to which they were exposed.

Although a great deal remains to be done that will improve the operation of a mobile computer-based instruction unit in the field, we believe that we have demonstrated the feasibility and desirability of incorporating CAI programs into inservice teacher education.

Keith A. Hall
November 25, 1969

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COMPUTER-ASSISTED INSTRUCTION AT CALIFORNIA, PENNSYLVANIA

Summer, 1969

Objective

The goal of the project described in this report was to field test at a third location a program of inservice education in modern mathematics and mathematics teaching methods for elementary teachers in the Appalachian region.[1] An IBM 1500 instructional system with 16 student terminals was installed in the Phillipsburg Elementary School in California, Pennsylvania, to administer the computer-based course to the teachers. This system was used from approximately 9:00 a.m. to 9:00 p.m., between July 14 and August 29, to provide individualized instruction for elementary school teachers and other educators who drove in from an average distance of approximately twenty-two miles. Records of the learning histories of the participating teachers were compiled and analyzed for evaluating the effectiveness of the course and for making course revisions.

Computer Configuration

An IBM 1500 student station consists of four optional display-response devices which may be used individually or in combination. The central instrument connected to the computer consists of a cathode-ray tube screen with sixteen horizontal rows and forty vertical columns for a total of 640 display positions. Information sufficient to fill the screen is available in microseconds from an internal random access disk. A light-pen device enables the learner to respond to displayed letters, figures and graphics by touching the appropriate place on the screen. A part of the CRT device is a typewriter-like keyboard which makes it possible for the learner to construct responses, have

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[1] For a summary of the need for new techniques of inservice instruction in modern mathematics, compare pp. 1-3 in Hall, K. A., Principal Investigator, Inservice Mathematics Education for Elementary School Teachers Via Computer-Assisted Instruction, Interim Report R-19, Computer Assisted Instruction Laboratory, The Pennsylvania State University, University Park, Pennsylvania, June 1, 1969, mimeographed.

them displayed at any author-desired point on the CRT screen and receive rapid feedback in the form of an evaluative message. Four dictionaries of 128 characters each of the course author's own design are capable of being used simultaneously; thus, it would be technically feasible to teach the symbols of Sanskrit, Chinese, English, and Greek simultaneously by means of CAI. An image-projector loaded with a 16mm microfilm is capable of holding 1000 images on a single roll and of accessing forty images per second under program control. An audio play/record device has just recently become available but was not utilized for this project. An electric typewriter on the system is a separate device which enables the student to receive a hard copy of the interaction or dialogue between himself and the computer.

The central processing unit, which can accommodate up to a total of thirty-two student stations (each complete with four devices), is an IBM 1130 computer with 32,768 words of core storage. (Sixteen stations were sufficient to allow 150 to 200 students to complete the instructional materials used for this project in about seven weeks.) In addition to the usual peripheral equipment, the central processor depends upon five IBM 2310 disk drives (2,560,000 words) for the storage of usable course information and operating instructions. Twin magnetic tape drives record the interaction between the program and the student for later analysis and course revision. Core storage cycle time is 3.6 microseconds and read/write time for disk storage is 27.8 microseconds per word.

Instructional Program

The computer-assisted instruction course in mathematics for elementary teachers and methods of teaching mathematics for elementary teachers was developed by Professors C. Alan Riedesel, Marilyn N. Suydam, and Cecil R. Trueblood of The Pennsylvania State University. The course adheres rather closely to the CUPM Level 1 recommendation with about eighty per cent of the course devoted to mathematical content and twenty per cent devoted to the methods of teaching mathematics. The methods units were interspersed throughout the program so that each would be studied immediately following the presentation of the related content.

The course utilizes an integrated approach relying not only on tutorial activity at the computer terminal but on the integration of printed instructional materials and manipulative devices to be used at the terminal and in

the teacher's classroom. Each participant in the project received a copy of Guiding Discovery in Elementary School Mathematics, by C. Alan Riedesel, and published by Appleton-Century Crofts, a handbook containing suggested lesson plans and problem assignments, and an assortment of manipulative devices such as Cuisenaire rods and counting sticks for use in the teacher-student's own room. A detailed course description is included as Appendix A of this report. A pre- and posttest of mathematics content, and pre- and posttest of the participant's attitude toward mathematics and a posttest of attitude toward CAI were administered to all participants in the project. The data from these inventories are documented in subsequent sections of this report.

Participants

A total of 130 students from 25 school districts registered for the computer-based inservice mathematics program at California. Of the 130 who registered for the course, 103 completed the course. Several factors were present which affected the students who signed up for the course and their later behavior in taking the course: a) some people hurried to finish so they could leave for vacation; b) the program attracted people who were already proficient in the measured skills and only took it for the purpose of confirming their own evaluation (ego-building); c) most people had a short lead time for planning to participate in the program. In addition, because of the individualized scheduling of attitude inventories and performance measures, coupled with the coordination of several proctors, it was very difficult to assure that all performance measures were administered to all students at the appropriate time. Of the total number who completed the course, there was relatively complete pre- and post-instruction data for 89 students which is presented in the remainder of this report.

EVALUATION OF ACHIEVEMENT

Marilyn N. Suydam and Harold E. Mitzel

Composition of the Mathematics Achievement Test

The "Test on Modern Mathematics," by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel, was used as the pre- and posttest measure of achievement for the computer-assisted mathematics course elmath for the participants in this project. The 80-item test was designed to include a representative sampling of mathematical content from each of the 12 chapters in the course, and therefore provides a measure with which to test understanding of the concepts contained in the CAI mathematics program. Although about twenty per cent of the student's "on-line" time dealt with the teaching of mathematics in the elementary school, questions on this material were not included in the achievement examination. The most appropriate test for methods material acquisition is probably found in the classroom setting.

The 80 multiple-choice questions were selected from a pool of approximately three hundred items about which some preliminary performance data had been gathered. These items approximated the numbers of knowledge, understanding, and application objectives included in each chapter of the course. Texts in mathematics education which were used to construct the course were consulted in the preparation of the test questions. In addition, a mathematician evaluated each item for appropriateness to the course material and for mathematical accuracy.

Form G of the "Test on Modern Mathematics" was used as the pretest, while Form H served as the posttest. The two forms contain the same items except that 1) the numerical values are changed in about one-half of the items, and 2) the order of answer options is different on almost all items in the two forms. While psychometric equivalence has not been established, we make the assumption that the two forms are equivalent since there were no substantive changes in content or format.

Achievement Test Results

A total of 89 persons (see Table 1) completed the CAI mathematics course at the California, Pennsylvania school. The pretest was administered at the session following each student's reaching the end of the course. In the intervening period of approximately seven weeks, the students spent an average of 16.80 hours on the program.

Table 1

Occupational Description of 89 Participants for Whom Pre- and Posttest Data Were Available

Occupation	Number	Per Cent
Primary School Teachers, Primary School Teacher Aides, and Intermediate Teachers	47	52.8
Junior and Senior High School Teachers	16	18.0
School Administrators and Coordinators	6	6.7
Others	20	22.5
Total	89	100.0

Table 2 shows the pre- and post-treatment results of the administration of the "off-line" mathematics achievement test. The increase in achievement is evident in the increase in the cumulative score column. Achievement in mathematics related to the instruction is also evidenced in the increase in the mean score from approximately sixty per cent on the pretest to approximately seventy-five per cent on the posttest.

If the assumption is made that the 80 items of the test represent an absolute criterion of achievement in the course, then theoretical mastery of the course objectives is attained when a student answers one hundred

Table 2

Frequency Distributions of Pre- and Post-Mathematics Achievement (80 items) for Educators Taught by CAI at California, Pennsylvania, Summer 1969

Per Cent of Criterion Test Correct	Frequency Pretest, Form G N = 134	Cum. Freq. in Per Cent	Frequency Posttest, Form H N = 134	Cum. Freq. in Per Cent
95 - 99	0	100.00	4	100.00
90 - 94	3	100.00	10	95.5
85 - 89	5	96.6	11	84.3
80 - 84	5	91.0	10	71.9
75 - 79	2	85.4	14	60.7
70 - 74	8	83.1	12	44.9
65 - 69	10	74.2	9	31.5
60 - 64	8	62.9	12	21.3
55 - 59	6	53.9	1	7.9
50 - 54	6	47.2	1	6.7
45 - 49	17	40.4	1	5.6
40 - 44	8	21.3	1	4.5
35 - 39	6	12.4	2	3.4
30 - 34	3	5.6	0	1.1
25 - 29	1	2.2	1	1.1
20 - 24	0	1.1	-	-
15 - 19	1	1.1	-	-
Mean (in per cent)	58.07		74.98	
Median (in per cent)	56.58		76.11	
Mode (in per cent)	47.00		77.00	

Note.--Descriptive statistics were calculated from grouped data.

per cent of the items correctly. In most practical achievement test situations, a ninety per cent criterion is considered realistic. It is obvious that for this test, only 14 of the 89 students achieved the desired level; mastery at the ninety per cent level was not attained by the remaining 75 students.

The reasons for some deficiency in the measure can be attributed to 1) the fact that the items include some "transfer of knowledge" objectives which were not specifically taught in the CAI program, and 2) there are probably insufficient direct practice materials and short review quizzes within the program to enable the less able students to reach the desired level of mastery of the objectives. A careful re-examination of the test has been undertaken to eliminate items on objectives not specifically taught. Evaluation of student responses has also led to revision of the test for future use with the program. Changes in the instructional program which were indicated by the responses on the test have been annotated in subsequent sections of this report.

As shown in Table 2, approximately thirty-seven per cent of the California students had, as indicated by their performance on the pretest, already achieved sixty per cent of the objectives of the course. For this group there was relatively little room to show evidence of growth in the test situation. However, in an inservice teacher education program, it is not possible to withdraw the opportunity for self-improvement once the pretest results are available. Moreover, scores on a test are only one indication of the need for a specified body of material. While the test includes a representative sampling of the content, it is by the very nature of its length only a sampling. Despite the fact that the test seems to indicate that thirty-seven per cent knew much of the material before taking the program, the development of the sequences and the wider range of concepts presented in the course possibly resulted in an increase in knowledge and understanding beyond what the particular test scores can indicate.

In spite of the limitations evident in the achievement test and/or in the program, the data show that the mean achievement for the students at California did increase. (The gain between pretest and posttest scores is

significant at the .001 level.[1]) The program is effective in providing in-service education for teachers of elementary school mathematics and other educators.

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[1]The raw score difference between pre- and posttest means was 13.26 which, when evaluated by t test for correlated means, gave the following results: $t = 7.05$ $p < .001$ d. f. = 88

EVALUATION OF ATTITUDES TOWARD MATHEMATICS

Marilyn N. Suydam and Harold E. Mitzel

Two notions about attitudes toward mathematics are widely accepted: 1) that mathematics is disliked by most pupils, and 2) that the teaching of mathematics is disliked by most teachers. However, results of numerous surveys contradict these notions. Many studies provide evidence which shows that pupils frequently select mathematics as their favorite or nearly favorite subject (Anderson, 1958; Chase, 1949; Curry, 1963; Dutton, 1956; Greenblatt, 1962; Herman, 1963; Inskeep, 1965; Mosher, 1952; Rowland, 1963; Stright, 1960).

As for teachers, Brown (1965) noted that while teachers feel inadequate in teaching mathematics, they still like to teach it. Groff's (1963) results supported this contention. Huettig and Newell (1966) noted that positive statements increased with the amount of training which a teacher reported.

Evidence has also been presented that the pupils of teachers who liked arithmetic, liked it themselves (Chase, 1958; Greenblatt, 1962).

Thus, it seems important to determine what effect a computer-assisted instruction course in mathematics has on the attitude of educators toward mathematics.

Development of the Mathematics Attitude Scale

The "Attitude Toward Mathematics" scale (by Marilyn N. Suydam and Cecil R. Trueblood) was developed from a pool of 75 items selected to express various feelings toward mathematics. The Likert format was used, with each statement worded in such a way that its content is favorable or unfavorable. Students then responded in terms of the degree to which they agree or disagree with the statement. Neutral items are not included. To reduce the potential effect of response set, care was taken to include an equal number of positively worded (favorable to mathematics) and negatively worded (unfavorable to mathematics) items.

The 75-item pool was submitted to 25 examinees who were asked to respond to each item with a five-point scale ranging from "strongly agree" to "strongly

disagree." Scale scores were then derived for each item, and the final selection of 26 items was based on 1) the level of the scale scores, and 2) independence of content of the item.

The value of the variate on the attitude scale was obtained by assigning arbitrary numerical weights to the options. The theoretical extremes of a distribution of scores for the 26 items are 26 and 130, with a theoretical midpoint of 78.

On administrations of the "Attitude Toward Mathematics" scale to several hundred students, the reliability (i.e., a measure of internal consistency, Cronbach's Coefficient Alpha) has ranged from .92 to .98, with an average reliability of .96.

Attitude Test Results

The "Attitude Toward Mathematics" scale was administered both before students began the CAI course and after they had completed it. Eighty-nine students enrolled at the California center completed the scale following instruction.

Table 3 presents the results. The mean score on the pretest was 92.82, while the mean score for the same group of students after completion of the CAI mathematics course was 96.52, a mean increase of 3.70. When the difference was evaluated with a t-test for correlated measures, this difference was found to be significant.[2]

Of far more importance is the fact indicated by the scores; the mean attitude score before teachers began the program was positive (greater than the scale's midpoint of 78) - not overwhelmingly so, but nevertheless on the positive side of the balance. Furthermore, after instruction it is even more positive. It is therefore hoped that the teachers will transmit a positive attitude about mathematics to their pupils, and thus the attitude of pupils toward mathematics will become increasingly positive.

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[2]The difference between pre- and post-instruction means was evaluated by t test for correlated measures with the following results:
$t = 2.840$ $p < .001$ d. f. = 88

Table 3

Distribution of Pre- and Posttest Attitude Scale Scores for 89 Students in CAI Program California, Pennsylvania, Summer 1969

Score	Pretest	Posttest
120 - 129	6	9
110 - 119	15	16
100 - 109	19	18
90 - 99	13	14
80 - 89	16	16
70 - 79	5	8
60 - 69	8	5
50 - 59	4	3
40 - 49	1	0
30 - 39	2	0
	89	89
Mean	92.815	96.522
Median	96.040	98.430
Standard Deviation	22.014	18.475

Note.--Descriptive statistics were calculated from ungrouped data.

It should also be noted that fears that interaction with computer terminals might generate negative feelings toward the subject matter were unfounded. Hopefully, further use of computers in teacher education can be used without fear of deteriorating subject matter motivation and interest.

ANALYSIS OF RELATIONSHIPS AMONG ACHIEVEMENT MEASURES, ATTITUDE MEASURES, AND TIME MEASURES

Marilyn N. Suydam and Harold E. Mitzel

Further analysis of the data for the group of educators who were taught by the CAI mathematics program reveals some interesting interrelationships between pairs of the several variables. Interpretations of correlational data may provide the basis for future controlled study of specific aspects of interest.

Table 4 presents the means and standard deviations for seven variables involving achievement, attitude, and time devoted to the study of mathematics via CAI. The achievement pretest and posttest scores were attained on Forms G and H respectively of the 80-item "Test on Modern Mathematics," described in a previous section of this report. The attitude pre- and posttest scores were derived from the "Attitude Toward Mathematics" scale previously described. Both pretests were administered prior to the student's first session at the student station, while the posttests were administered immediately following the student's last session. In order to ascertain time spent by students while taking the CAI course, three measures were recorded: the number of separate sessions when each student was "on-line"; the number of days intervening between each student's first and final sessions (a rough indicator of the extent to which the course was massed or distributed); and the actual amount of time at the student terminal, as recorded by the computer.

Table 5 presents the correlations between the paired observations for these seven variables (two achievement measures, two attitude measures, and three time measures). It was expected that a high positive correlation would exist between achievement pre- and posttest scores. This is a generally prevalent finding since what a student achieves may be partially predicted by his entering level, or what he has achieved in the past. The positive correlation coefficient of .8020 is therefore an indication that high achievers on the pretest tended to be high achievers on the posttest, and low achievers tended to achieve at the lower levels on both tests. If, however, the achievement test had been a satisfactory mastery or criterion-referenced test, this correlation would be decidedly lower. The goal in aiding the student to achieve mastery

Table 4

Means and Standard Deviations on Seven Variables
for Students Taught Modern Mathematics by CAI
at California, Pennsylvania, Summer 1969

Variable	Mean	Standard Deviation
Achievement pretest raw score	46.34	13.61
Achievement posttest raw score	59.60	11.31
Attitude pretest raw score	92.82	21.81
Attitude posttest raw score	96.46	18.26
Number of separate sessions	8.79	3.09
Number of days between first and last session	17.15	9.37
Number of hours "on-line" at terminal	16.82	5.26

of a body of material is precisely to eliminate a strong pre-post relationship. All students, whether they scored high or low on the pretest, should reach approximately the same high level on the posttest. The present achievement test for the course is undergoing revision in order to more closely approximate the goal.

That the attitude pre- and posttest scores were highly correlated was also predictable. Measurable changes in attitude generally demand a longer time span than the seven weeks of this project. The correlation coefficient of .8293 is indicative that some relative changes in attitude did occur among the participants; as previously noted, the mean attitude score became slightly more positive during the instruction period.

The correlation coefficients between measures of achievement and attitude on the one hand, and time assessments on the other, are all negative. This observation is merely indicative of the fact that longer periods of time spent by students on the course and low achievement or attitude tended to be related.

The negative coefficients, however, are generally not extreme and, in fact, two are not statistically significant. One exception is the relationship

Table 5

Zero-Order Correlations Between Measures on Seven Variables for Students Taught Modern Mathematics by CAI at California, Pennsylvania, Summer 1969

Variable a	Variable b	Correlation Coefficient
Achievement pretest score	Achievement posttest score	.8020
	Attitude pretest score	.5202
	Attitude posttest score	.5636
	Number of hours on terminal	-.3805
	Number of sessions	-.1783[a]
	Number of days between first and last session	-.4993
Achievement posttest score	Attitude pretest score	.4993
	Attitude posttest score	.5427
	Number of hours on terminal	-.2965
	Number of sessions	-.1655[a]
	Number of days between first and last session	-.4938
Attitude pretest score	Attitude posttest score	.8293
	Number of hours on terminal	-.3234
	Number of sessions	-.2196
	Number of days between first and last session	-.2526
Attitude posttest score	Number of sessions	-.3186
	Number of hours	-.2247
	Number of days between first and last session	-.2755
Number of hours on terminal	Number of sessions	.6864
	Number of days between first and last session	.6071
Number of sessions	Number of days between first and last session	.2283

[a]This coefficient is not statistically significant at the five per cent level of confidence.

between pre- and posttest achievement and amount of time on the terminal (-.3805 and -.2965, respectively). High achievers typically spent less time at the student station than low achievers. Again we see a weakness in the combination of instructional programs/examinations since theoretically learners with lower ability or lower previous knowledge should be able to use "time on the program" to compensate for their poor starting position.

Amount of time on terminal was found to be related to the number of sessions (.6864) and the number of lapsed days between first and last session (.6071). That the coefficient of .2283 between numbers of sessions and lapsed days is no higher is related to scheduling constraints.

The data relating to time "on-line" and achievement were also analyzed in another way to study the relationships existing between them. Correlations between posttest achievement and each measure of time were determined when achievement pretest scores were used as a co-variate, or held constant. Thus it was possible to look at the relationship which would have existed had all pretest achievement scores been equal.

The correlation coefficients between posttest achievement score and number of lapsed days (with pretest achievement constant) was -.0382, while the posttest achievement coefficient with number of sessions was -.0157 under the same conditions. Both of these coefficients are statistically nonsignificant. The coefficient between posttest achievement and number of hours on terminal (with pretest achievement constant) was -.1805. When pretest achievement was uncontrolled, the corresponding coefficient was -.2965, indicating that a portion, but not all, of the relationship between achievement and time on the terminal is explained by what the learner brings with him in the way of subject matter knowledge.

The data in Tables 6, 7, and 8 demonstrate the tremendous flexibility of an individually presented CAI course as might be compared with conventional instruction formats. Presented in a conventional manner in a classroom with a stand-up lecturer, we believe that this course in modern mathematics and the teaching of mathematics would require a minimum of 30 clock hours of in-class time. Under the CAI format with student-controlled progress, only one student, or about one per cent of the enrollees, required more than 30 hours. At the same time, 34 students, or about thirty-nine per cent, required less than 15

Table 6

Frequency Distribution of Number of Hours of Terminal Time for 89 Students Taught Modern Mathematics by CAI at California, Pennsylvania, Summer 1969

Number of Hours	Frequency
33 - 35	1
30 - 32	0
27 - 29	6
24 - 26	4
21 - 23	6
18 - 20	14
15 - 17	24
12 - 14	29
9 - 11	4
Total	89

Mean = 16.94 Median = 15.81 Mode = 13.00 Hours

Table 7

Frequency Distribution for Number of Days Intervening Between Initial and Final Sessions for 89 Students Taught Modern Mathematics by CAI at California, Pennsylvania, Summer 1969

Number of Days	Frequency
36 - 39	3
32 - 35	6
28 - 31	10
24 - 27	3
20 - 23	11
16 - 19	13
12 - 15	12
8 - 11	- 17
0 - 3	0
Total	89

Mean = 17.15 Median = 16.20

Table 8

Frequency Distributions for Number of Sessions on Terminal for 89 Students Taught Modern Mathematics by CAI at California, Pennsylvania, Summer 1969

Number of Sessions	Frequency
21 - --	0
19 - 20	1
17 - 18	1
15 - 16	1
13 - 14	5
11 - 12	14
9 - 10	22
7 - 8	22
5 - 6	19
3 - 4	4
0 - 2	0
Total	89

hours to complete the program. (The median is 15.81 hours.) For this group of 34 students, instructional time was halved.

In studying the temporal experiences of the group of educators who took the CAI mathematics course at California, note should be made of the extremes. On the number of hours at the student station measure (Table 6), the range was 29.0 hours, or, viewed another way, it took the slowest student 5.8 times as long to complete the course as the fastest student. This finding, that CAI tends to accentuate individual differences in task completion time, has been characteristic of every one of our teaching experiences with this medium (c. f. Hall, 1969; Long and Riedesel, 1967).

In Table 8, the range of different sessions employed by the students was 16, indicating that many people, when provided the opportunity, preferred to work a small number of relatively long three- to four-hour sessions. Others

preferred and utilized a larger number of short sessions. These adaptations, made more or less spontaneously by students, tend to emphasize one of the potentially important advantages of computer-based instruction. A maximum amount of flexibility seems to be of particular significance for inservice or job concurrent training. We believe that the educational demand for inservice education is going to increase markedly in the years immediately ahead and that CAI, based on our field experience in places like California, can help to satisfy that burgeoning need.

CURRICULUM REVISIONS

Cecil R. Trueblood and Diane Knull

The purpose of this report is to indicate the type and number of revisions which were made based on the analysis of student records and on-site observations. In this report we have chosen not to present illustrations and detailed discussion of what each type revision entails. If you wish such examples, please refer to the previous two interim reports (Hall, 1969a, 1969b). However, the course outline is presented in Appendix A.

Course Content Revisions

Using the data in the detailed student records and the original program, the authors determined whether a revision of course content or Coursewriter II instructions was required. The operation of the course at the California site yielded data which dictated the course revisions as shown in Table 9.

Table 9

Type and Number of Course Revisions

Operation Codes Requiring Revision	Number of Revisions
ep	5
un feedback	13
ca	5
fn	11
ca feedback	3
dt	7
wa feedback	4
lp	4

In addition to the revisions based upon student records, the recommendations of the proctors and the systems manager were used to generate new frames for several chapters. Since the need for these changes were not reflected by

student records, this source of information proved to be very useful in improving the program. Two types of revision were made based upon these on-site observations. New frames were added after which the old and new frames were resequenced to improve the course flow.

On-line Course Evaluation

Two forms of a general achievement test have been put on-line--the pretest (Form I), and the posttest (Form J). The 80 items on the pre- and the posttests are all multiple-choice questions, and they can be answered by using the keyboard. All the students will receive the same six questions in the beginning and the same six questions at the end. The other 68 questions are randomly generated and therefore vary in the order in which each student receives them.

The second test placed "on-line" is a 26-item mathematics attitude scale. It will be given to determine the student's attitude toward mathematics before and after completing the course. Since the choices on this test vary on a continuum from agree to strongly disagree, students will respond by using the light pen. They will also be encouraged to make any comment they wish following their response to each item.

The use of on-line course evaluation was initiated for several reasons: 1) to standardize and at the same time individualize the administration of the pre- and posttests, 2) to take advantage of student record feedback for future course revision, 3) to gain the possibility of being able to investigate some of the problems related to testing students via CAI.

EXPRESSED STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

Karl G. Borman

The rationale for attempting to measure a student's opinion toward computer-assisted instruction has been presented in two previous reports (Borman, 1969a, 1969b). Briefly, the rationale may be summarized as follows: A student with a positive opinion about his teacher or, more generally, a method of instruction will be more motivated to attend class, learn, and retain the material than a student with a negative opinion of the mode of instruction. Therefore, the evaluation of a technique of instruction, such as computer-assisted instruction, should include a measure of student opinion toward the instructional medium, as well as a measure of the knowledge gained from the use of that particular medium. Ideally, the students should have a favorable attitude toward the mode of instruction.

The Student Opinion Survey (SOS) described in this section of the California report is an instrument designed to measure a student's opinion toward computer-assisted instruction (CAI) as an instructional technique.

The Opinion Survey

The instrument, composed of 42 items related to the student's experiences while taking a course via CAI, is administered at the computer terminal (on-line administration). The items were adapted from a paper and pencil test (off-line administration) previously developed at Penn State (Brown, 1966) and revised on the basis of subsequent data (Borman, 1969a.) Each item is a statement relative to computer-assisted instruction.

The students taking the SOS used the light pen attached to cathode ray tube (CRT) terminal to indicate the degree to which they agreed with a statement (strongly agree, agree, uncertain, disagree, strongly disagree) or the degree of applicability of the statement (all of the time, most of the time, some of the time, very seldom, never) (see Appendix B). A weight of 1 to 5 was assigned to each response to indicate the degree to which the response described a favorable opinion toward CAI. This method of weighting provides for a spread of scores between 42, indicating the most unfavorable opinion toward CAI, and 210, indicating the most favorable opinion toward CAI. A theoretical neutral score would be 126.

Following each response, the student was given the opportunity to type comments (up to 200 characters) he wished to make related to that item in order to clarify or explain the reasons for his answer.

In addition, following the 42 structured items, the student was asked to type a response of not more than 200 characters explaining why he did or did not like CAI. These responses, as well as the optional comments, were not scored and were not included as part of the student's score.

Administration

Upon the completion of the modern mathematics course (elmath) on line, students were automatically administered the Student Opinion Survey. Data were available on 93 students; however, 4 students' data were incomplete, resulting in a total of 89 students who provided the data for this report.

In all cases, the students were told to be frank, that there was no one right answer to a question, that their opinions would be kept confidential, and that they were required to answer each question.

Results

The coefficient alpha reliability of the Student Opinion Survey administered at this location was .80, a result slightly lower than comparable figures obtained in earlier settings of this program at Dryden and Gladeville, Virginia, (.84 and .88 respectively). The average Student Opinion Survey score was 158.6 and one student had a slightly negative opinion toward CAI. The entire distribution of scores is shown in Table 10.

It was hypothesized that a student's opinion toward CAI may be related to his performance in mathematics or the amount of time required to complete elmath. However, the correlations between mathematics achievement posttest scores and Student Opinion Survey scores and total time required to complete elmath (in seconds) and Student Opinion Survey Scores were not significantly different from zero (see Table 11) indicating that these variables were not related to SOS scores. This may be taken to indicate that both high achievers and low achievers expressed favorable opinions toward CAI and those students who rapidly completed the elmath course as well as those who required longer periods of time also expressed favorable opinions toward CAI.

Table 10

Distribution of Student Opinion Survey Scores for 89 Students in CAI Program California, Pennsylvania, Summer 1969

Score	Frequency
180 -	3
170 - 179	14
160 - 169	27
150 - 159	25
140 - 149	14
130 - 139	5
120 - 129	1
	N = 89

Mean = 158.6

Median = 159

Standard Deviation = 12.31

Note.--Descriptive statistics were calculated from ungrouped data.

Table 11

Means, Standard Deviations and Correlation Coefficients of Two Variables Hypothesized to Influence SOS Scores

Score	Mean	S. D.	Correlation With SOS Scores
Posttest Achievement Score	59.91	11.38	.11
Time Required To Complete elmath (in seconds)	1009.00	311.6	.05

Student Comments

These results are also verified by the comments that the students typed. Some typical comments follow:

I liked the CAI course very much. In high school I hated math.

I did enjoy this course. I realize that you are only a machine and that there is much improvement to be made, example, your acceptance of responses. On the whole I found it quite interesting.

I liked this course because it's the first time I've even remotely enjoyed any type of math (except geometry). I think I've learned something at last.

I worked at my own pace which is beneficial and I did not feel pressured.

Thank you for your ideas.

I was pleasantly surprised at the lack of tension I felt in taking a course that was always difficult for me to master. There was a high degree of motivation. Congratulations and thanks.

I liked CAI because you received immediate feedback for your responses. I am normally very poor in mathematics and I feel that it [CAI] has helped me gain a better understanding of some concepts.

I felt the course was tremendous in every way. The experience was great. Thank you for making it possible, and your interest in me as a student and teacher.

CAI made learning fun and enjoyable.

I appreciated flexibility in scheduling.

There were also some negative comments, the most common was that the students could not get the computer to accept alternative correct answers. For example:

> I felt, at times, that I needed someone to explain things more, and to discuss things with me.
>
> I became a little upset when the computer refused correct answers because of different terms. Otherwise, I've enjoyed the class.

Conclusion

With the exception of one student, all of the 89 students completing the computer-assisted instruction course on inservice mathematics education for elementary school teachers at California, Pennsylvania, obtained scores on the Student Opinion Survey which indicated a favorable opinion toward CAI. This score did not appear to be the result of poor achievement in mathematics or of an unduly long time required to complete the CAI program. The comments typed by the students upon the completion of the survey also verify the conclusions. The results obtained at Dryden and Gladeville, Virginia,are also in agreement with these results. From these findings, it may be inferred that the students were highly motivated to learn and would be willing to take further instruction via CAI.

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APPENDIX A

Course Description: elmath

The Pennsylvania State University

Computer Assisted Instruction Laboratory
201 Chambers Building
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Course Description: elmath

The CAI course elmath is designed to present mathematical content and methods of teaching that content in the elementary school. The content component was developed at The Pennsylvania State University by Dr. C. Alan Riedesel and Dr. Marilyn N. Suydam. The methods component was developed by Dr. Cecil R. Trueblood with Dr. Riedesel and Dr. Suydam.

The primary purpose of the content materials is to present the mathematics which a teacher should know in order to develop a successful program in the elementary school. It is based on CUPM recommendations for Level 1 courses, modified to meet the actual requirements of the schools in which it is visualized for use. The methods materials place stress on various strategies and techniques, including the use of manipulative materials.

As over-all learning outcomes, the teacher should be able to understand and apply:

(1) the mathematical content

(2) generalizations about teaching procedures, including:

(a) Physical world situations should be used to facilitate concept development.

(b) Many varying materials should be used to facilitate concept development.

(c) Experiences should range from the concrete to the abstract.

(d) Individual differences must be considered in planning and in teaching.

(e) Pupils should be asked to discover and use many varying ways of finding solutions to problems.

(f) Pupils should be asked to explain, deduce, generalize, and apply.

(g) Questions of many types should be asked to provoke discussion, develop concepts, and refocus on problems.

In addition to the CAI program, a textbook on teaching elementary school mathematics is required: Riedesel, C. Alan, Guiding Discovery in Elementary

School Mathematics (New York: Appleton-Century-Crofts, 1967). A handbook with a summary of mathematical content and a section on activities and materials to use in the classroom is also provided: Part I, Help to You in Learning Mathematics, by Roy F. Shortt (Keuka College, Keuka Park, New York), and Part II, Help to You in Teaching Mathematics, by Cecil R. Trueblood (The Pennsylvania State University).

For use in evaluation of learning, there are an eighty-item test ("A Test on Modern Mathematics," Forms G and H, by Marilyn N. Suydam, Cecil R. Trueblood, and C. Alan Riedesel) and an attitude scale ("Attitude Toward Mathematics," by Marilyn N. Suydam and Cecil R. Trueblood). A scale to measure changes in attitude toward CAI is also available.

An outline of the course follows:

Chapter 1: Sets and Early Number Experiences

Content

1. Sets
   a. Elements of sets
   b. Finite and infinite sets
   c. Defined sets
   d. Set notation
   e. Empty set
   f. Universal set
   g. Subsets

2. Set relationships
   a. Equality
   b. Equivalence

3. Set operations
   a. Union
   b. Intersection

4. Complement of a set

Methods

This section focuses attention on why and how sets are presented in early number work. Attention is also directed toward the materials and techniques the teacher should use and the questions she should ask. Levels of pupil performance are considered in terms of types of pupil response.

Chapter 2: Exponents

Content

1. Interpreting exponential notation
   a. Repeated factors
   b. Powers: base and exponent
2. Expressing in exponential form
3. Expanding from exponential form
4. Computation with exponents
   a. Multiplication
   b. Division
   c. Addition and subtraction
5. Zero as an exponent
6. Using expanded notation

Methods

How to teach exponential notation so that pupils see its usefulness is featured. Various pupil-teacher exchanges are presented. Use is made of graph paper and blocks to illustrate exponential forms.

Chapter 3: The Hindu-Arabic System

Content

1. Numerals and word names for numbers

2. Place value
   a. Numerals and names through thousands place
   b. Patterns
      (1) Powers of 10
      (2) Expanded form and standard numerals

   c. Chart: periods and place value through quadrillions
      (1) Reading the numeral
      (2) Completing the chart

Methods

Introducing pupils to the use of place value charts is considered. This is connected with work with the abacus and multi-base arithmetic blocks. The reading of numerals to quadrillions is also considered.

Chapter 4: Other Numeration Systems

Content

1. Introduction to base eight
   a. Symbols: counting
   b. Place value
   c. Changing from base ten to base eight
      (1) Finding powers of the base
      (2) Division by the base

2. Introduction to base five
   a. Changing from base five to base ten
   b. Changing from base ten to base five

3. Characteristics of any numeration system
   a. Number of symbols
   b. Writing the base

4. Introduction to base twelve
   a. Changing from base twelve to base ten
   b. Changing from base ten to base twelve

5. Introduction to base two
   a. Changing from base ten to base two
   b. Changing from base two to base ten

6. Addition in other bases
   a. Base five
   b. Base two

7. Multiplication in base five

Methods

Ways of introducing other numeration systems are presented. Use of materials such as the place value chart is considered, and attention is directed to points at which pupils may have difficulty.

Chapter 5: Addition of Whole Numbers

Content

1. Addition as a binary operation

2. Addition as one of four operations
   a. Relation to subtraction
   b. Relation to multiplication

3. Addition as the union of disjoint sets

4. Counting as the basis for addition: use in problem solving

5. Aids for teaching addition
   a. Abacus
   b. Number line
   c. Cuisenaire rods
   d. Place value frame

6. Properties and principles of addition
   a. Closure
   b. Commutativity
   c. Associativity
   d. Identity element

7. Addition basic facts: use of the table

8. Addition algorithms for multi-digit examples
   a. Use of place value
   b. Use of properties
   c. Regrouping
   d. Expanded notation forms

9. Historical forms for addition
   a. Sandboard method
   b. Scratch method
   c. Front-end addition

10. Checking addition
    a. Excess of nines
    b. Excess of elevens

Methods

For this chapter, the methods component is interwoven with the content. Stress is placed on the use of verbal problems and manipulative materials such as the abacus and Cuisenaire rods.

Chapter 6: Subtraction of Whole Numbers

Content

1. Subtraction on the number line

2. Subtraction as the inverse of addition

3. Terminology
   a. Addend, missing addend, sum
   b. Minuend, subtrahend, difference

4. Subtraction in terms of sets
   a. Complements
   b. Difference between universal set and subset

5. Properties and principles of subtraction
   a. Closure
   b. Commutativity
   c. Associativity
   d. Compensation and renaming

6. Subtraction basic facts: use of the addition table

7. Subtraction algorithms
   a. For basic facts
      (1) Additive method
      (2) Take-away method
   b. For multi-digit examples
      (1) Decomposition
         (a) Additive
         (b) Take-away
      (2) Equal additions
         (a) Additive
         (b) Take-away

8. Checking subtraction
   a. Adding
   b. Excess of nines
   c. Excess of elevens
   d. Complementary method
   e. Scratch method

9. Subtraction in base eight

Methods

Procedures for introducing subtraction to pupils are developed. Also reintroduction using the abacus as a vehicle is presented, and attention is focused on ways of teaching multi-digit subtraction using expanded notation.

Chapter 7: Multiplication of Whole Numbers

Content

1. Multiplication as repeated addition, using the number line

2. Terminology
   a. Multiplier, multiplicand, product
   b. Factors and product

3. Multiplication in terms of sets

4. Arrays and ordered pairs

5. Properties and principles of multiplication
   a. Identity element
   b. Closure
   c. Commutativity
   d. Associativity
   e. Distributivity

6. Multiplication basic facts: use of the table

7. Multiplication algorithms for multi-digit examples
   a. Regrouping
   b. Use of place value

8. Checking multiplication
   a. Use of properties
   b. Excess of nines
   c. Excess of elevens

9. Historical forms for multiplication
   a. Finger reckoning
   b. Lightning method
   c. Scratch method
   d. Lattice method
   e. Duplation methods

10. Modulus multiplication
    a. Mod 2
    b. Mod 7

Methods

Use of arrays in teaching multiplication is developed. Emphasis is placed on providing pupils with varying methods for finding answers to multiplication questions.

Chapter 8: Division of Whole Numbers

Content

1. Relation of division
   a. To multiplication
   b. To subtraction

2. Terminology
   a. Dividend, divisor, quotient
   b. Types: partition and measurement

3. Properties and principles of division
   a. Closure
      (1) Exact division
      (2) Inexact division
   b. Commutativity
   c. Associativity
   d. Right distributivity
   e. Use of zero except as a divisor
   f. Identity element

4. Division algorithms
   a. For basic facts: use of the multiplication table
   b. For multi-digit examples
      (1) Subtracting groups of the divisor
      (2) Use of place value
      (3) Estimation of quotient
         (a) Approximation
         (b) Compensation
         (c) Determining devisibility

5. Historical forms for division
   a. Galley method
   b. A danda method
   c. Division by factors
   d. Excess of nines

6. Division in base four

Methods

Procedures for the diagnosis of pupil difficulties in division are developed. Provision for individual differences is focused on through the study of procedures for estimating the quotient in division.

Chapter 9: Functions

(to de developed)

Chapter 10: Integers

Content

1. Defining the set of integers
   a. Negative signed numbers
   b. Additive inverse

2. Computation with integers

3. Properties and principles of integers
   a. Closure
   b. Commutativity
   c. Associativity
   d. Distributivity
   e. Identity element

4. Order relations of integers

Methods

Three strategied for introducing a lesson are analyzed and compared. The way in which a teacher can use a textbook with other materials is developed.

Chapter 11: Fractions

Content

1. Defining the set of rational numbers

2. Terminology of fractions

3. Uses of fractions
   a. To express parts of a group and parts of a whole
   b. To name a rational number
   c. To indicate division
   d. To express a ratio

4. Characteristics of fractions
   a. Identity element
   b. Equivalence
   c. Cross-products test
   d. Renaming in simplest form
      (1) Prime numbers
      (2) Composite numbers
      (3) Numbers that are relatively prime

5. Order relations of fractions; mixed forms

6. Properties of fractions
   a. Commutativity
   b. Associativity
   c. Distributivity

7. Computation with fracti
   a. Addition
      (1) Like denominators
      (2) Unlike denominators
   b. Finding the L.C.M.
   c. Finding the G.C.D.
   d. Subtraction
      (1) Like denominators
      (2) Unlike denominators
   e. Multiplication
   f. Division
      (1) Common denominator method
      (2) Multiplicative inverse method (inverse)

Methods

Attention if focused on a lesson plan for summarizing the various uses of fractions. The selection of behavioral objectives and analysis of strengths and weaknesses of the plan are included.

Chapter 12: Decimals

Content

1. Place value for decimals
2. Reading and writing decimals
3. Locating decimals on the number line
4. Renaming
   a. Fractions as decimals
   b. Decimals as fractions
5. Terminating decimals
6. Non-terminating decimals
   a. Repeating
   b. Non-repeating
7. Computation with decimals

Methods

Use of a physical world situation to introduce decimals is emphasized with the presentation of a lesson with an odometer. Pupil participation through the use of multiple solutions is reviewed, and non-verbal problems are suggested.

Chapter 13: Ratio and Per Cent

Content

1. Ratio
   a. Expressing ratios
   b. Solving problems with ratios
   c. Using the cross-product method

2. Per cent
   a. Three types of problems
      (1) What is N% of a number?
      (2) What per cent is one number of another number?
      (3) Find the total (100%) when a per cent is known
   b. Five approaches to solving each type of problem
      (1) Decimal
      (2) Ratio
      (3) Unitary-analysis
      (4) Formula
      (5) Equation

Methods

This section is essentially a review and test of material presented in chapter 10 of the course textbook by Riedesel. When and how ratio and per cent should be developed are emphasized.

APPENDIX B

Student Opinion Toward Computer-Assisted Instruction

STUDENT OPINION TOWARD COMPUTER-ASSISTED INSTRUCTION

1. The method by which I was told whether I had given a right or wrong answer became monotonous.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

2. Nobody really cared whether I learned the course material or not.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

3. I felt challenged to do my best work.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

4. I felt isolated and alone.

All the time	Most of the time	Some of the time	Very Seldom	Never

5. I felt as if someone were engaged in conversation with me.

All the time	Most of the time	Some of the time	Very Seldom	Never

6. As a result of having studied by this method, I am interested in learning more about the subject matter.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

7. I was more involved in operating the terminal than in understanding the course material.

All the time	Most of the time	Some of the time	Very Seldom	Never

8. The learning was too mechanical.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

9. I felt as if I had a private tutor.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

10. The equipment made it difficult to concentrate on the course material.

All the time	Most of the time	Some of the time	Very Seldom	Never

11. The situation made me quite tense.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

12. Computer-assisted instruction, as used in this course, is an inefficient use of the student's time.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

13. My feeling toward the course material after I had completed the course was favorable.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

14. I felt frustrated by the situation.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

15. I found the computer-assisted instruction approach in this course to be inflexible.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

16. Material which is otherwise interesting can be boring when presented by CAI.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

17. I was satisfied with what I learned while taking the course.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

18. In view of the amount I learned, this method seems superior to classroom instruction for many courses.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

19. I would prefer computer-assisted instruction to traditional instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

20. Computer-assisted instruction is just another step toward de-personalized instruction.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

21. I was concerned that I might not be understanding the material.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

22. The responses to my answers seemed appropriate.

All the time	Most of the time	Some of the time	Very Seldom	Never

23. I felt uncertain as to my performance in the programmed course relative to the performance of others.

All the time	Most of the time	Some of the time	Very Seldom	Never

24. I was not concerned when I missed a question because nobody was watching me.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

25. I found myself just trying to get through the material rather than trying to learn.

All the time	Most of the time	Some of the time	Very Seldom	Never

26. I knew whether my answer was right or wrong before I was told.

All the time	Most of the time	Some of the time	Very Seldom	Never

27. In a situation where I am trying to learn something, it is important to me to know where I stand relative to others.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

28. I guessed at the answers to some questions.

All the time	Most of the time	Some of the time	Very Seldom	Never

29. I was aware of efforts to suit the material specifically to me.

All the time	Most of the time	Some of the time	Very Seldom	Never

30. I was encouraged by the responses given to my answers of questions.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

31. In view of the time allowed for learning, I felt too much material was presented.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

32. I entered wrong answers in order to get more information from the machine.

All the time	Most of the time	Some of the time	Very Seldom	Never

33. I felt I could work at my own pace.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

34. Questions were asked which I felt were not related to the material presented.

All the time	Most of the time	Some of the time	Very Seldom	Never

35. I was aware of the flickering screen while I was taking the course.

All the time	Most of the time	Some of the time	Very Seldom	Never

36. Material which is otherwise boring can be interesting when presented by CAI.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

37. I could have learned more if I hadn't felt pushed.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

38. I was given answers but still did not understand the questions.

All the time	Most of the time	Some of the time	Very Seldom	Never

39. The course material was presented too slowly.

All the time	Most of the time	Some of the time	Very Seldom	Never

40. The responses to my answers seemed to take into account the difficulty of the question.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree

41. While on computer-assisted instruction, I encountered mechanical malfunctions.

All the time	Most of the time	Some of the time	Very Seldom	Never

42. Computer-assisted instruction did not make it possible for me to learn quickly.

Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree